System of Systems (SoS) M&S VV&A Decomposition:

Integrated System Level VV&A (ISLA)

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Purpose

- The purpose of this brief to propose an approach for performing “system of system” level V&V of the BMDS representations.

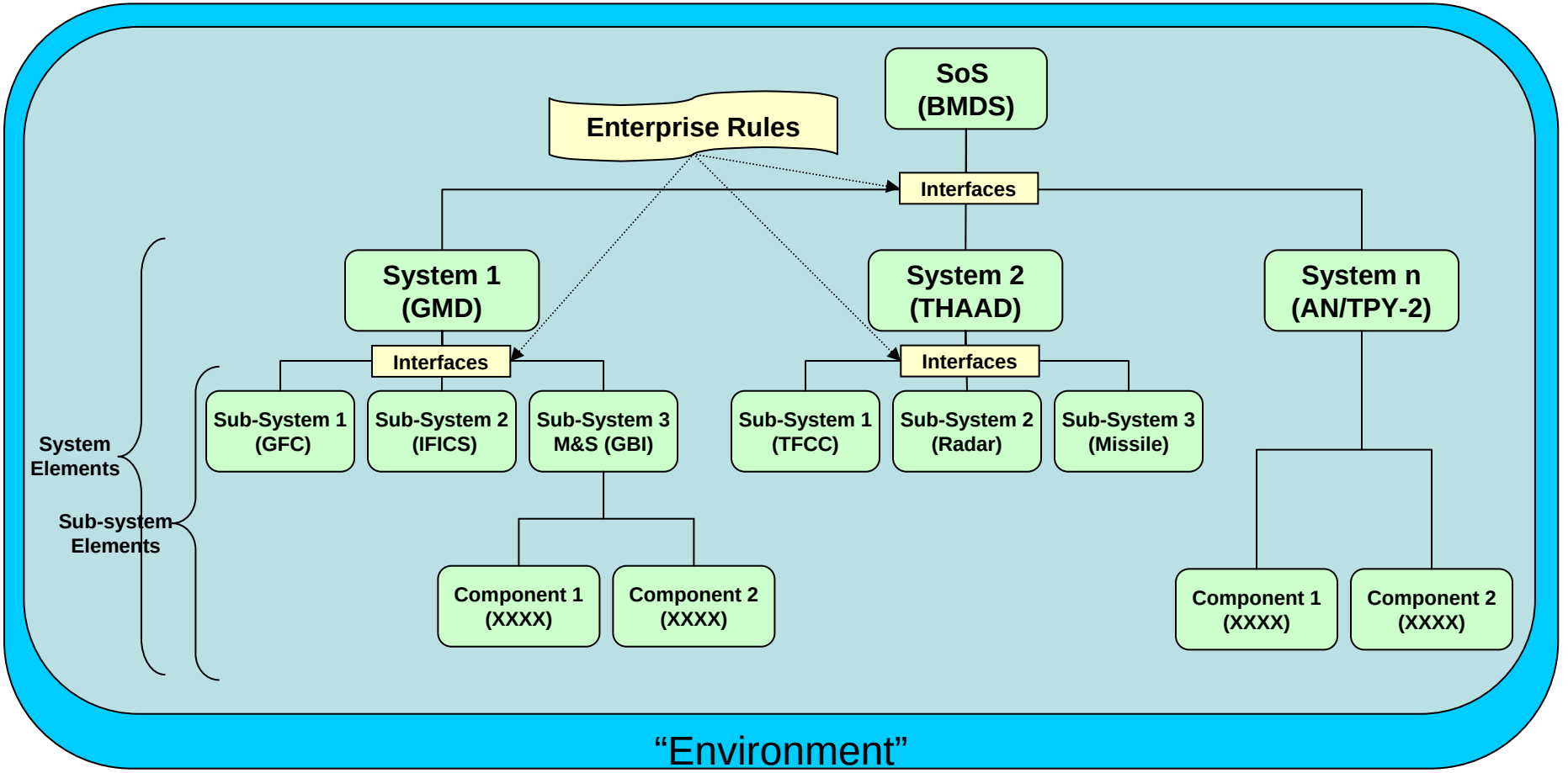
BMDS SoS Hierarchical View

System-Level (SoS) V&V

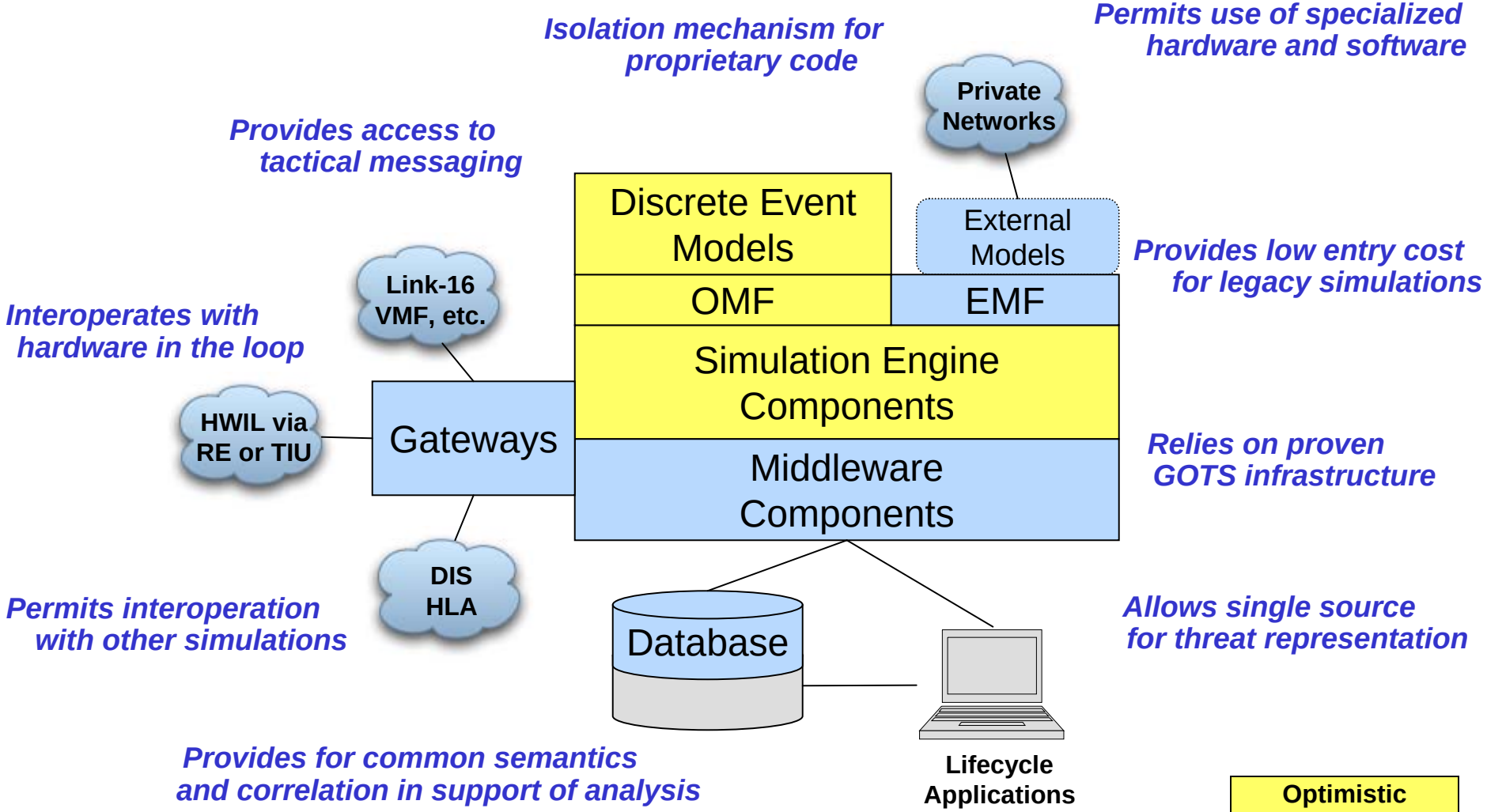
- SoS Interfaces
- SoS Behavior
- SoS Framework
- Boundaries
- Enterprise Rules
- Scenarios
- Metadata model

Element-Level (System) V&V

- System Interfaces
- System Rules
- System Framework
- Data model



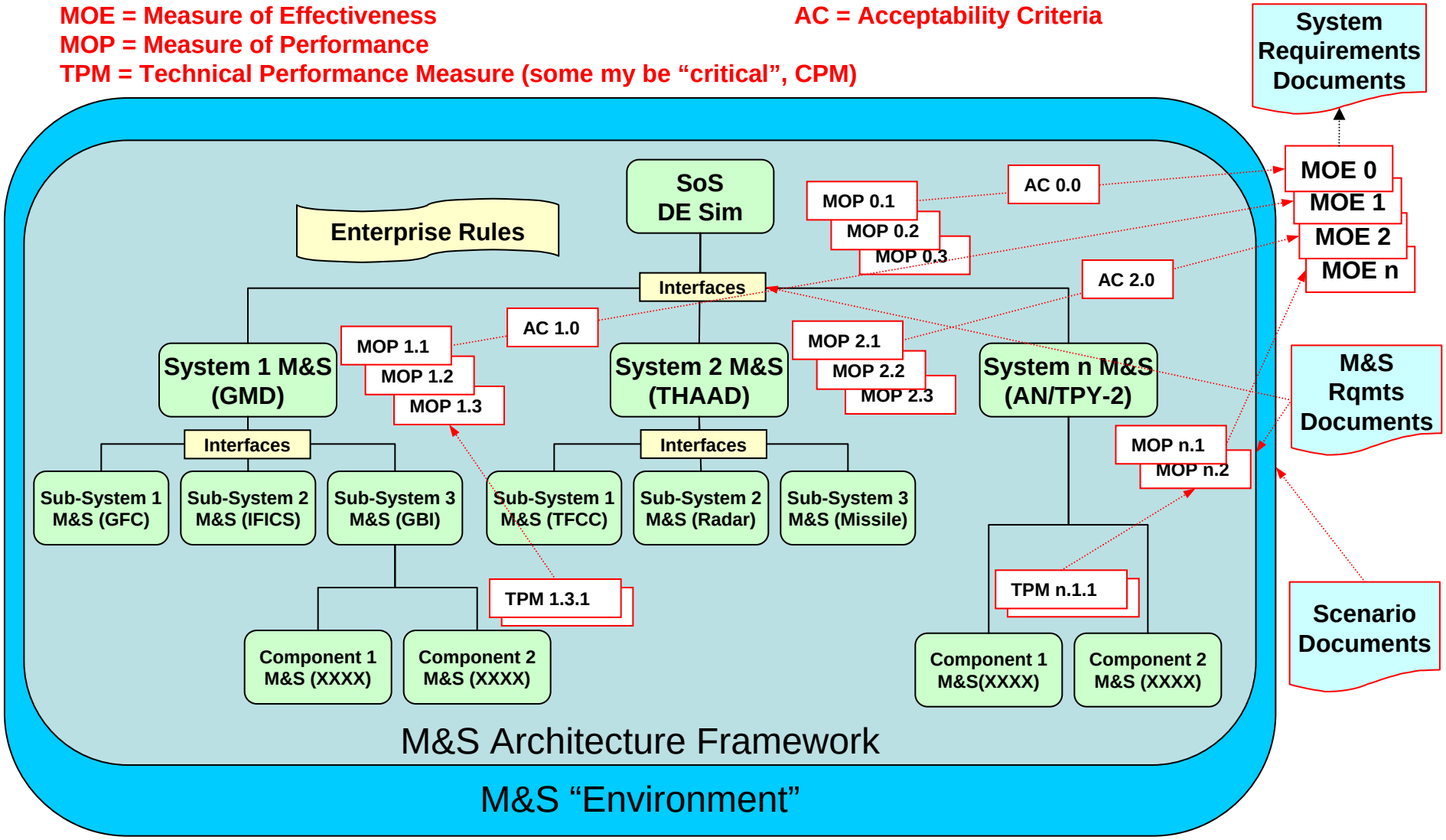
BMDS SoS M&S Architecture Characteristics (U)



BMDS SoS M&S VV&A Tool Metric Dendritic

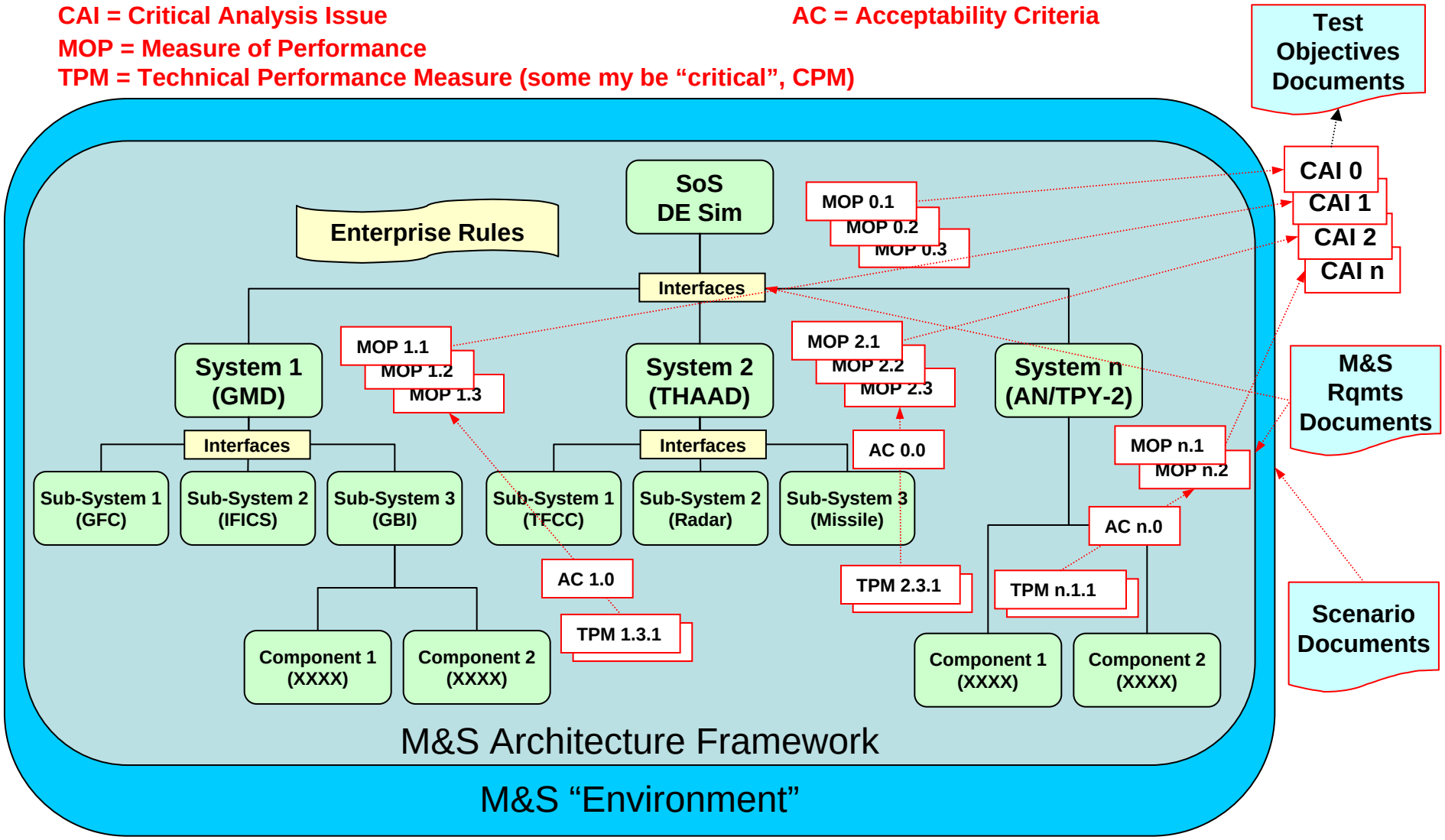
MOE = Measure of Effectiveness
MOP = Measure of Performance
TPM = Technical Performance Measure (some my be "critical", CPM)

AC = Acceptability Criteria

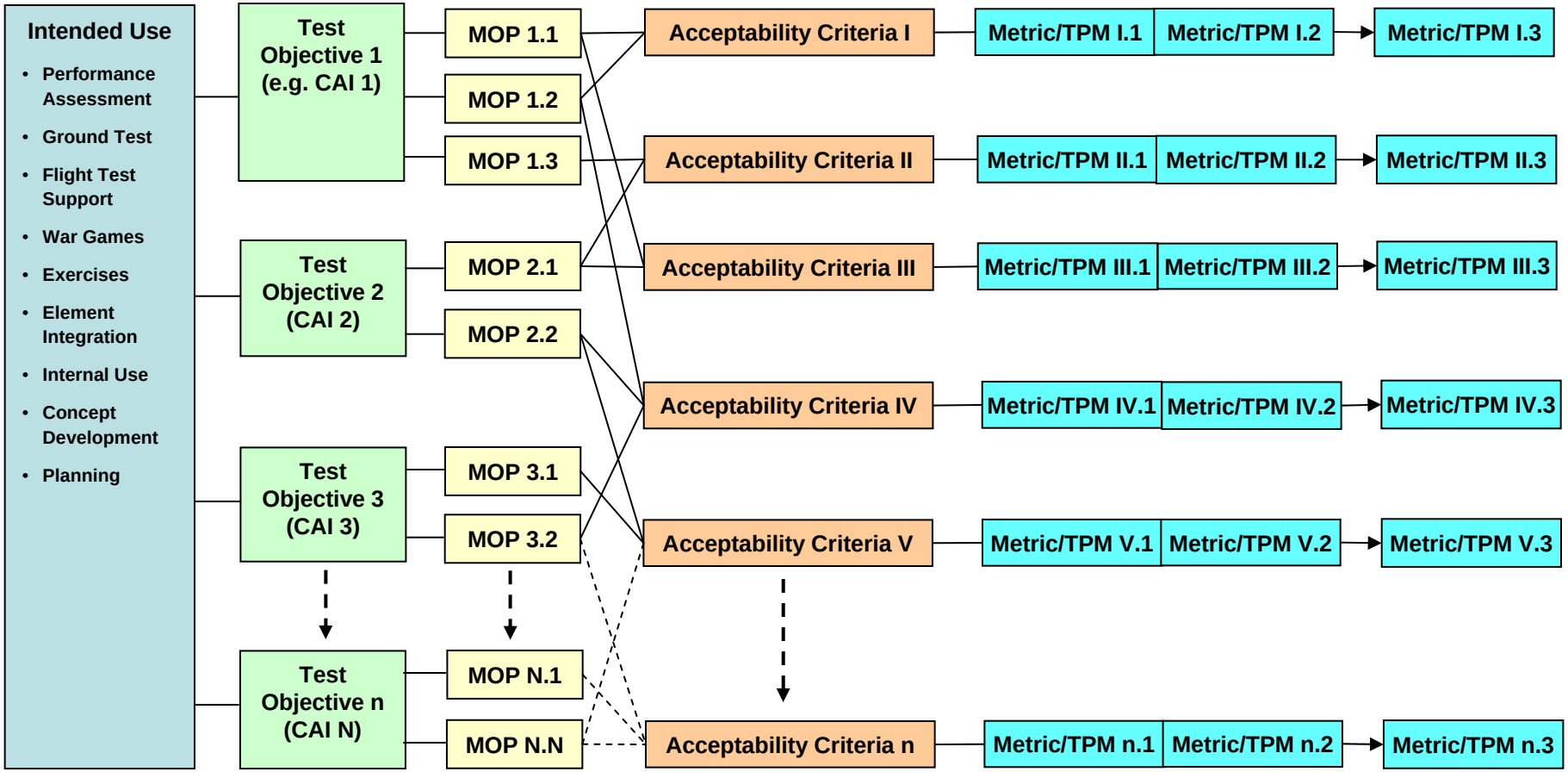


BMDS SoS M&S VV&A Event Metric Dendritic

CAI = Critical Analysis Issue
MOP = Measure of Performance
TPM = Technical Performance Measure (some my be "critical", CPM)
AC = Acceptability Criteria



Test Objective Relationship to Acceptability Criteria

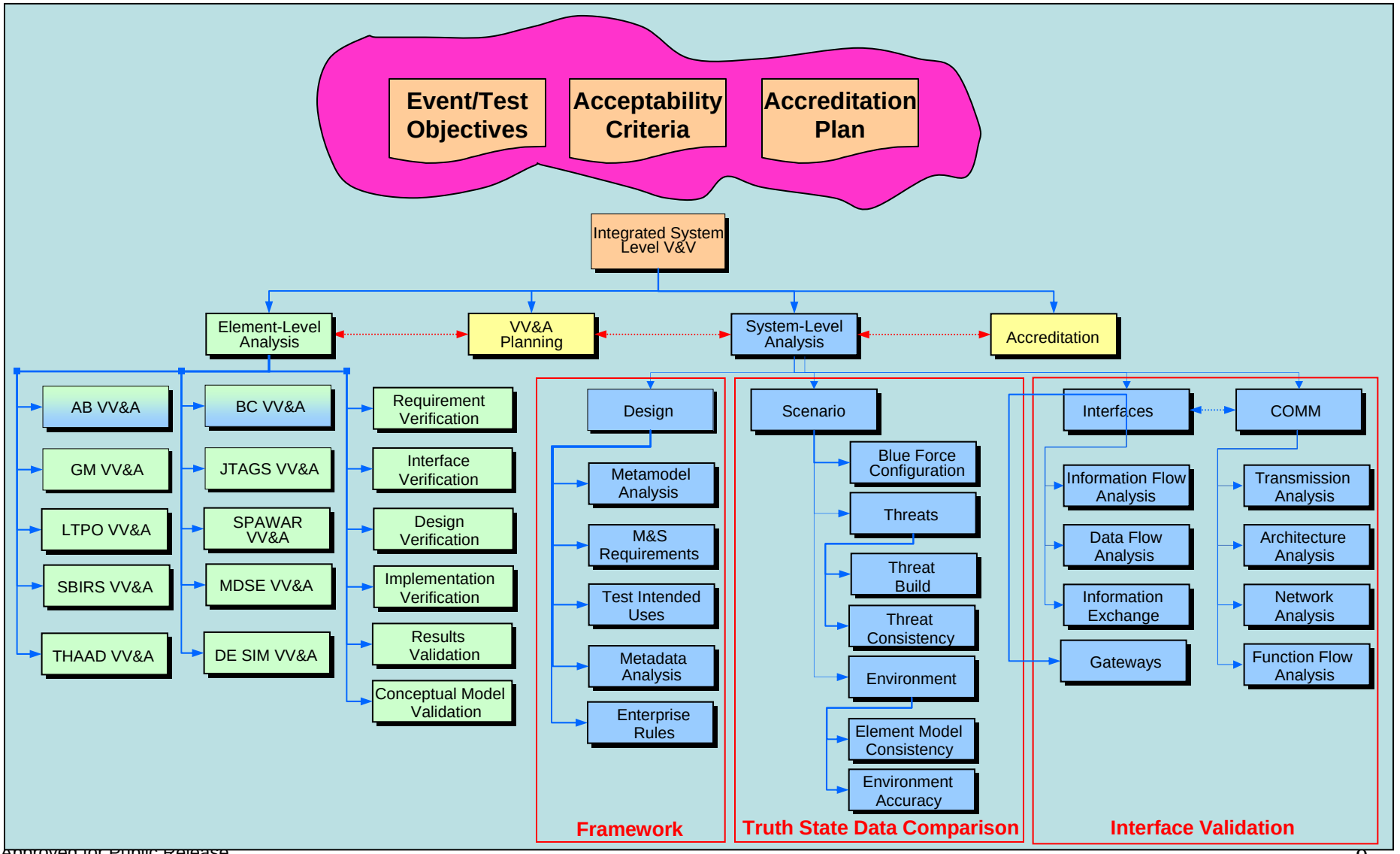


Test Objectives focus on the expected performance assessment of the operational BMDS to be completed using data from the test event

Issues

- Which interfaces are “truly” SoS level
- How do we V&V interfaces?
- What in DSA corresponds to a Federation Object Model (FOM) in HLA?
- How do we achieve meta-model validation in the absence of a conceptual model?
- What constitutes a metadata model?

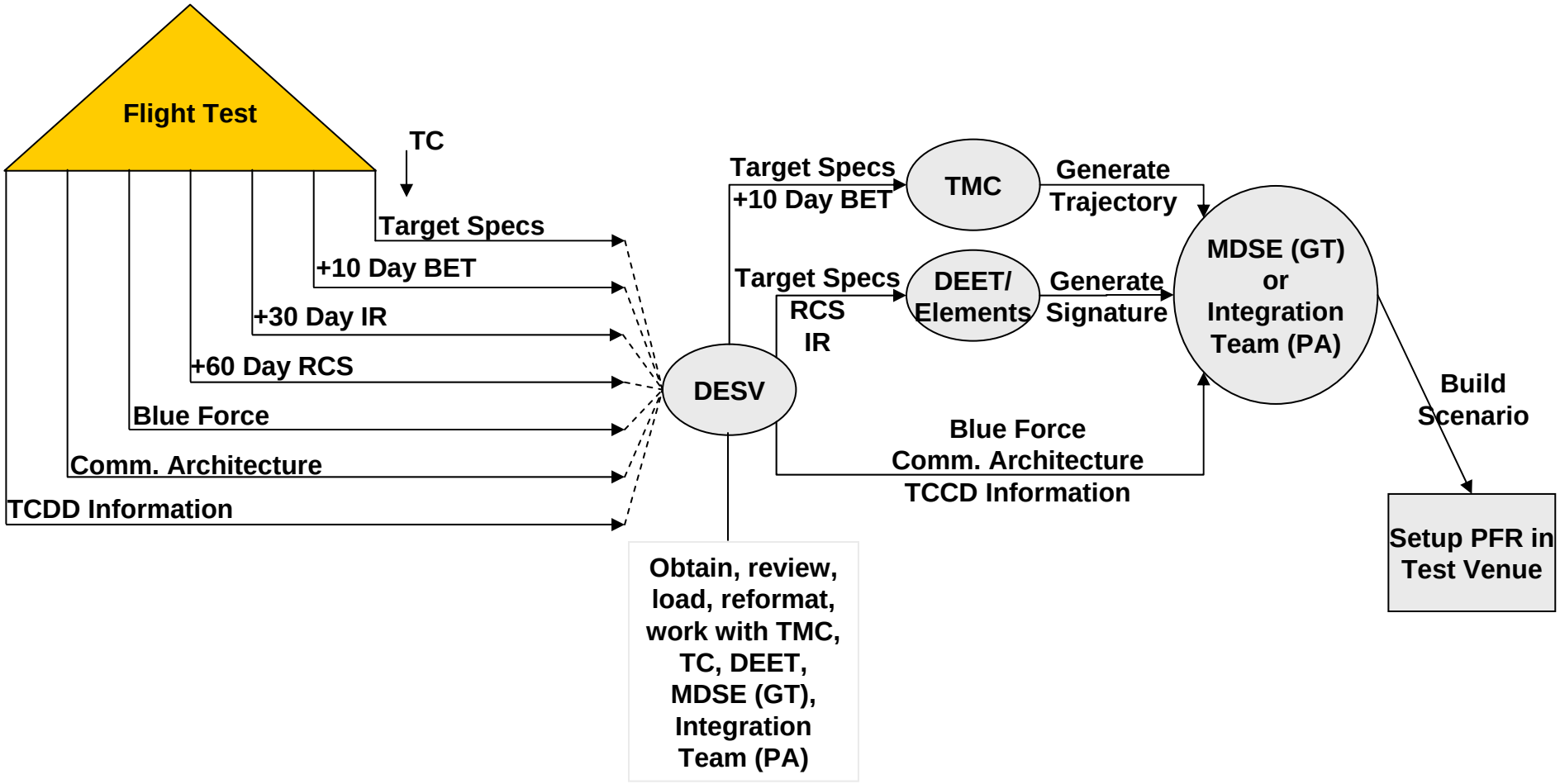
SoS M&S Verification & Validation Requirements



Testing the Theory Through System-Level Post-Flight Reconstruction (U)

- System-Level Post-Flight Reconstruction (PFR):
  - » Manually recreate and run a past flight test scenario in a test venue performing system-level comparative analysis of the real-world performance to the output of the test venue assessing the results and determining if system-level anomalies exist in the M&S
- System-Level Anchoring (SLA):
  - » Perform root cause analysis of the system-level anomalies found in the PFR; generate, test and implement M&S improvements to address anomalies

M&S System-Level PFR Preparation Process (U)



Backup

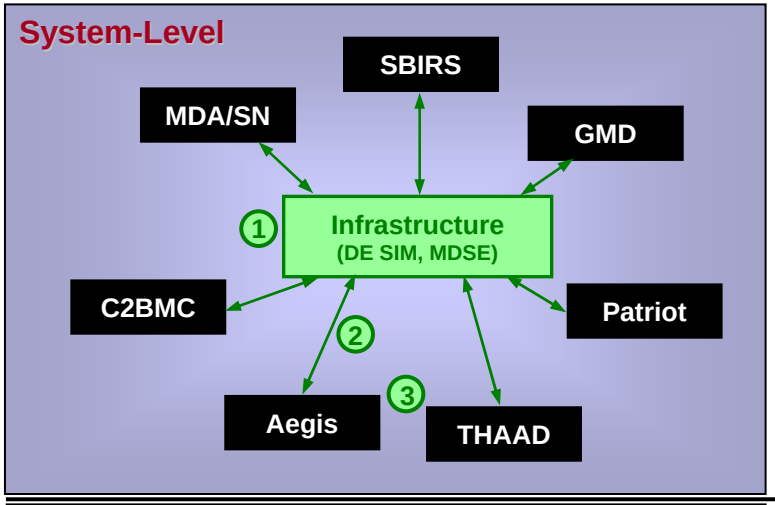
Terms of Reference (1)

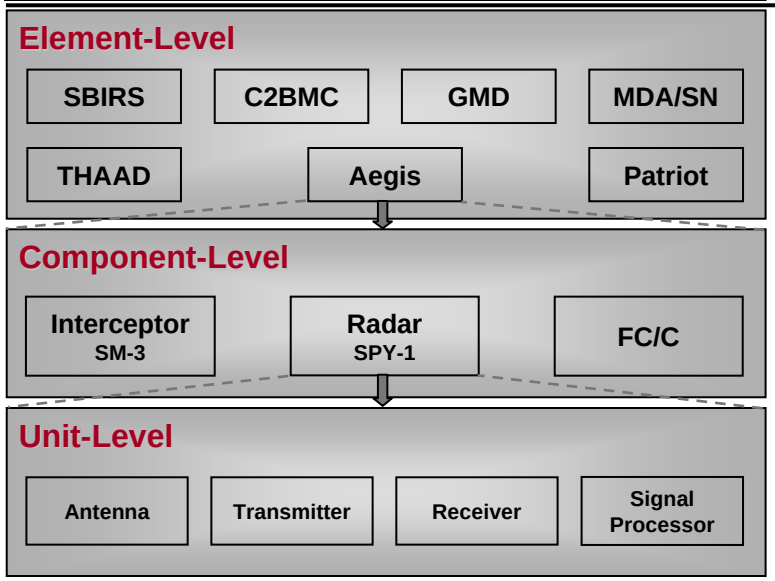
- System: A combination of interacting elements organized to achieve one or more stated purposes.
- System Element: a member of a set of elements that constitute a system. A system element is a discrete part of a system that can be implemented to fulfill a specified requirement.
- System of Systems: A combination of interacting functional system elements, which are themselves systems, organized to achieve a stated operational capability.
- Interface: At point at which independent systems or diverse groups interact. The devise or system by which interaction at an interface is effected.
- Enterprise Rules: Rules that govern the interaction of system elements; serve the role of “local government” within the SoS; specified in the Simulation Federation Object Model (framework), for example.
- Verification: The process of determining that a model implementation and its associated data accurately represent the developer's conceptual description and specifications.
- Validation: The process of determining the degree to which a model and its associated data are an accurate representation of the real world from the perspective of the intended uses of the model.

Terms of Reference (2)

- Measure of Effectiveness (MOE): A qualitative or quantitative measure of aggregate performance or a characteristic of a model, simulation or system that indicates the degree to which it performs the task or meets an operational objective or requirement under specified conditions.
- Measure of Performance (MOP)**:** The measure of how the system/individual performs its functions in a given environment (e.g., number of targets detected, reaction time, number of targets nominated, susceptibility of deception, task completion time). It is closely related to inherent parameters (physical and structural) but measures attributes of system behavior.
- Metadata**:** Information describing the characteristics of data; data or information about the meaning of data; descriptive information about an organization's data, data activities, systems, and holdings.
- Metamodel**:** A model of a model. Metamodels are abstractions of the M&S being developed, which use functional decomposition to show relationships, paths of data and algorithms, ordering, and interactions between model components and subcomponents. Metamodels allow the software engineers who are developing the model to abstract details to a level that subject matter experts can validate.
- Modeling and Simulation (M&S)**:** The use of models and simulations, either statically or over time, to develop data as a basis for making managerial or technical decisions. This includes but is not limited to, emulators, prototypes, simulators, and stimulators.

System-Level V&V – Roles & Responsibilities





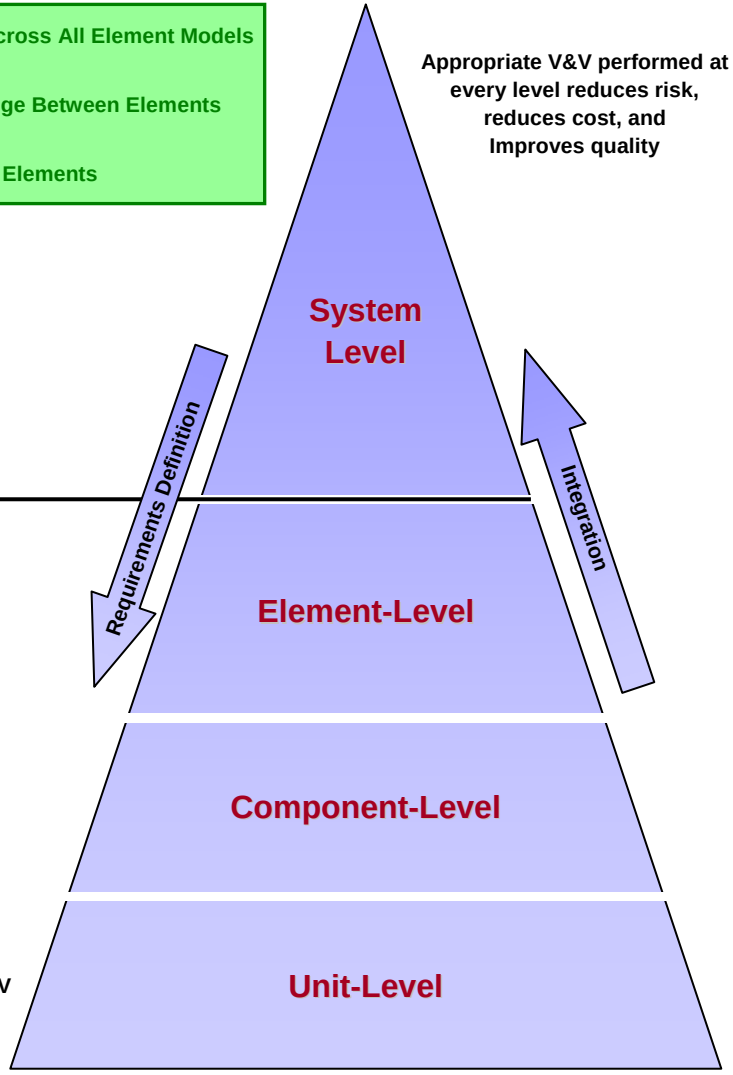
1. Ensure Consistent Inputs Across All Element Models
2. Analyze Information Exchange Between Elements
3. Analyze Interfaces Between Elements

DESV Responsibility

Element Responsibility

A firm V&V foundation is critical to enable successful system-level V&V

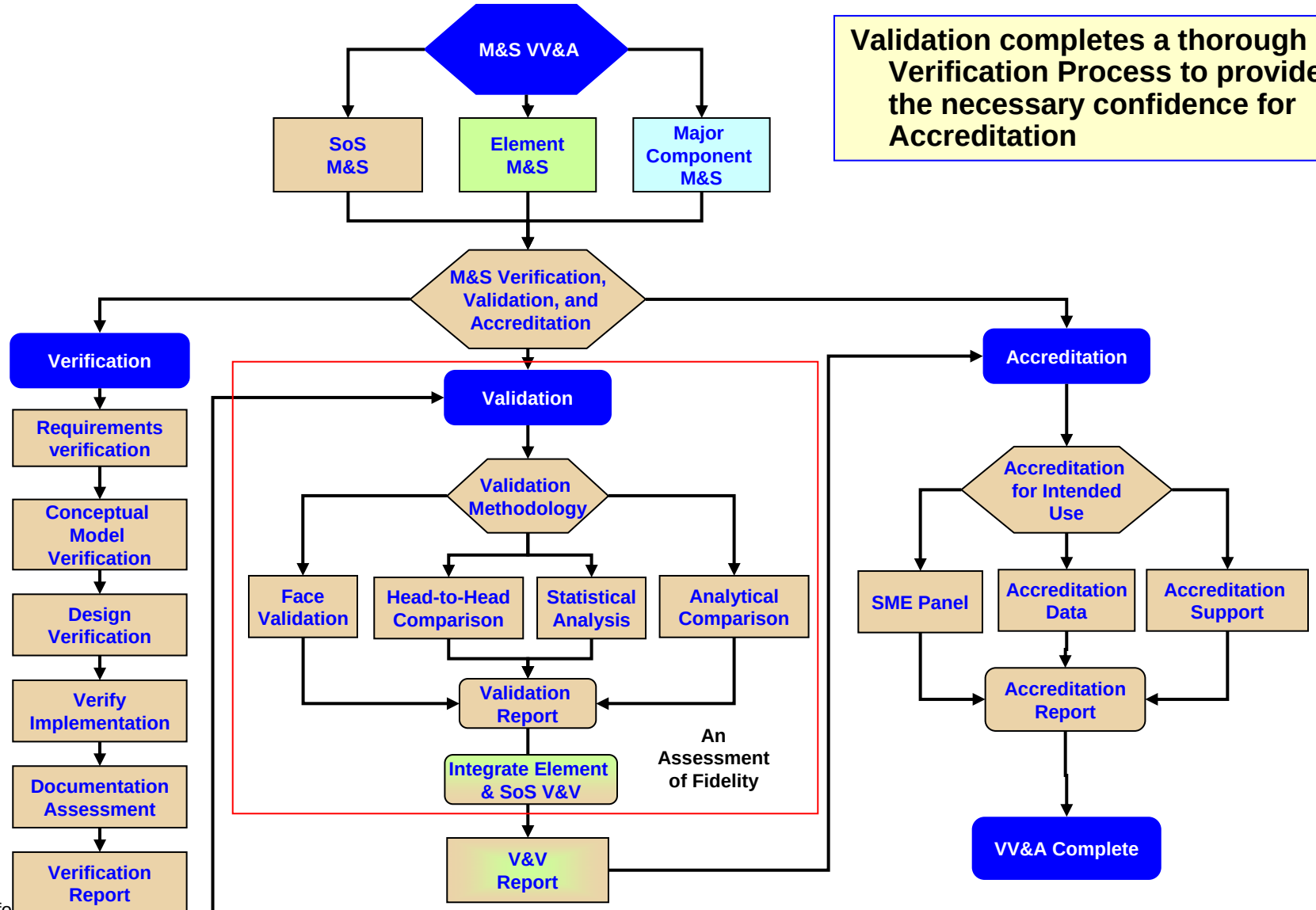
Appropriate V&V performed at every level reduces risk, reduces cost, and Improves quality



System-Level V&V Ensures Consistent Inputs Across Element Models and Includes Analyzing Communication Data and Interfaces Between Elements

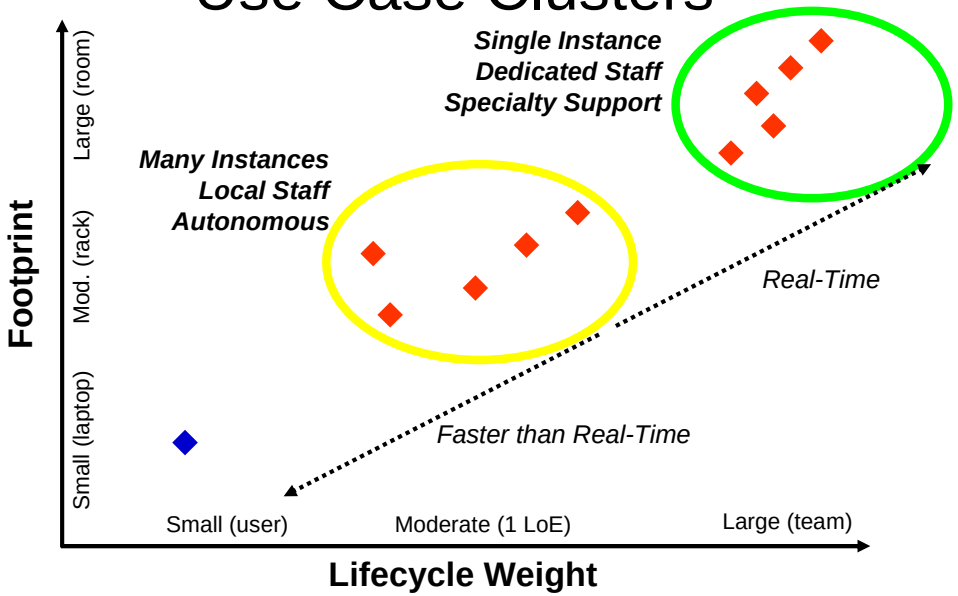
How Integrated V&V Supports Accreditation

Validation completes a thorough Verification Process to provide the necessary confidence for Accreditation



Simulation Use Cases

Use Case Clusters

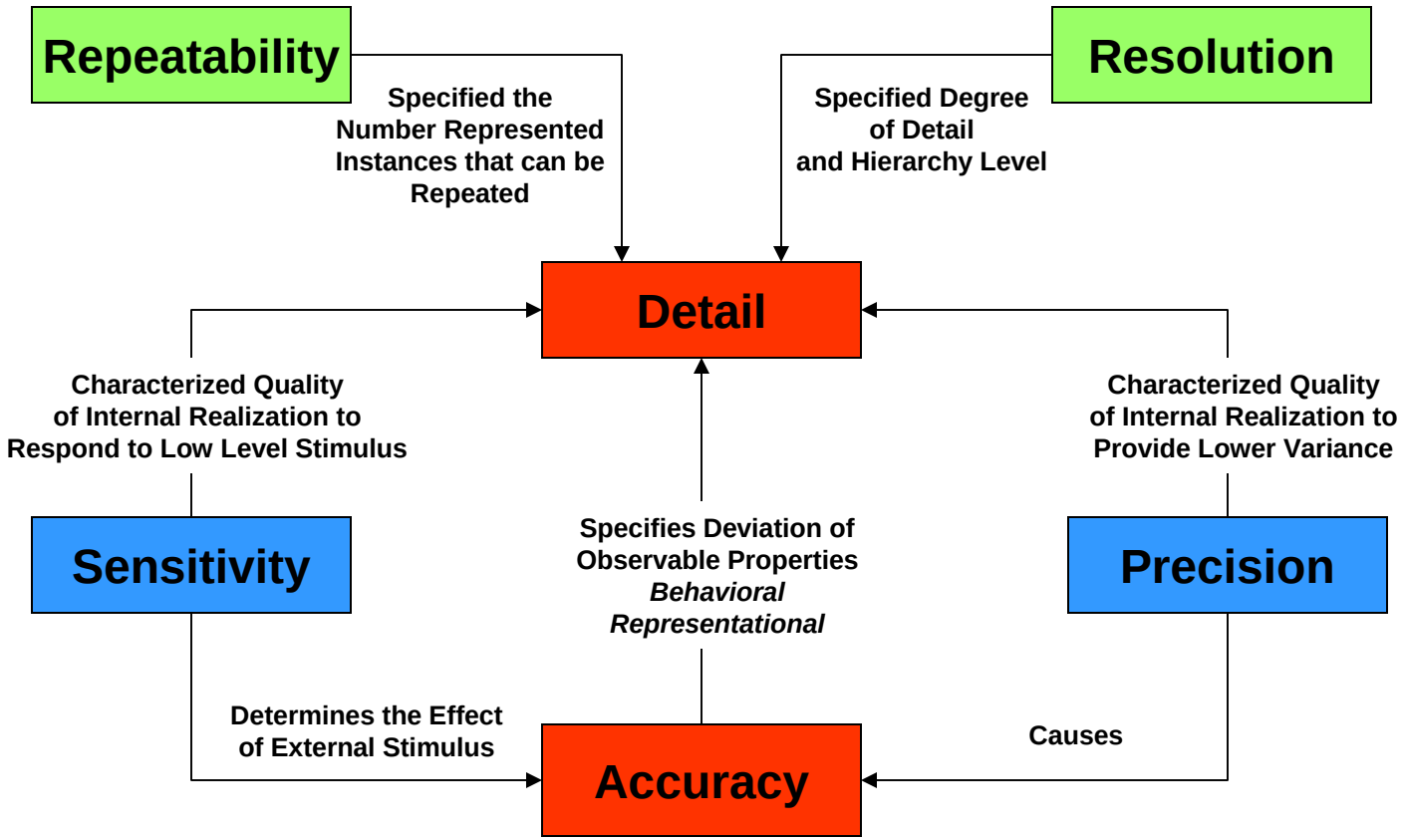


- BMD Simulation Use Cases
  - Tend to cluster when organized by support personnel and hardware footprint
  - A single simulation (conceptual model) is likely to poorly serve the complete space of use cases

- High Fidelity Cases
  - Addressed by engineering simulation models integrated through EMF
  - Marginal improvement over today's (PA07) executions
  - Ideally suited for interaction with HWIL simulation and ground and flight tests

- Medium Fidelity Cases
  - Necessary for support of concept exploration, future capabilities, high run count statistical analyses
  - Gaining credibility will require sound modeling, solid benchmarking to high fidelity simulations, and repeated use

SISO Fidelity ISG Concepts



Fidelity is defined as the accuracy of the representation when compared to the real-world [DoD 5000.59-M; DoD M&S Glossary, Dec 1997].